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UMOS-AQ / MIST

Canada

Improving O3, PM25 and NO2 GEM-MACH15 surface fields by optimally interpolating Updatable MOS (UMOS) forecasts

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DESCRIPTION

For the last few years an Updatable MOS (UMOS) methodology in air-quality forecasting (UMOS-AQ) has shown great ability to improve on direct model output.

The UMOS-AQ system produces one equation for each station, predictand, model run, forecast hour and season. One of the limitations of the technique is that we only obtain point forecasts. Furthermore, the point forecasts do not correspond to the public forecast (SCRIBE) network of stations.

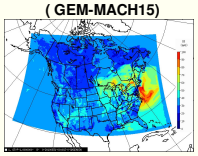
An optimal interpolation of the UMOS-AQ forecasts using simple kriging, in which the GEM-MACH15 model's output is used as a trial field, is presented as a solution. The kriging parameters chosen are such that the radius of influence is approximately two grid points with most of the weight coming from the UMOS-AQ forecasts.

Preliminary results were very encouraging in showing significant improvements over the model's forecast in regions where there is a high density of observation stations and the project attained operational status in the summer of 2011.

Overview

OBSERVATIONS (NAPS)

AIR QUALITY MODEL (GEM-MACH15)

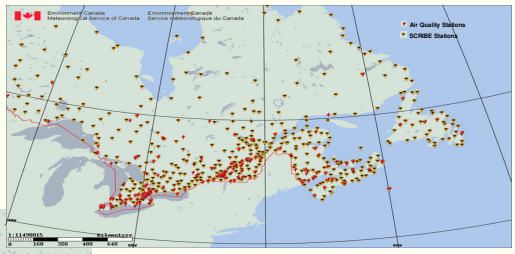


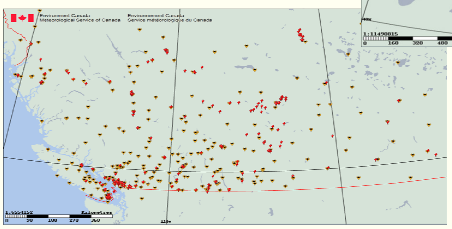
INTERPOLATION ENGINE (MIST)

FORECAST

Air Quality and SCRIBE Station Distribution

- Total stations in UMOS-AQ Dictionary: 231
  - O3 is reported hourly by ~ 180 stations
  - PM25 is reported hourly by ~ 170 stations
  - NO2 is reported hourly by ~ 130 stations
- Total stations in SCRIBE: 954





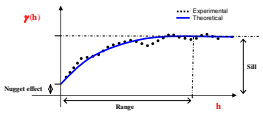
Most air quality observation stations are not collocated with the SCRIBE stations

Kriging Set Up and Design

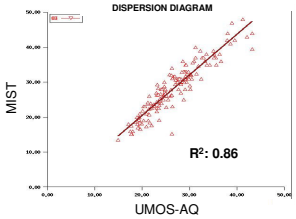
A semivariogram describes the degree of *spatial dependence of a field* :

$$\gamma(h) = \frac{1}{2N_h}\sum_{i=1}^{N_h}(z_i - z_{i+h})^2$$

z_i is the value at point i
z_{i+h} is the value at a distance h
N_h is the total number of points separated by distance h



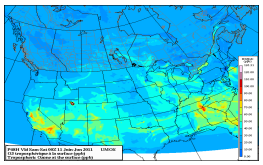
- By performing a semivariogram analysis and optimization we set specific parameters in order to optimally interpolate the variable.
- We use the model output as a trial field.
- By setting the correlation length to 2-3 grid points we only modify the model's output in areas where there is a presence of air quality stations.
- Linearly interpolating the resultant field at the SCRIBE points can be slightly less accurate than the UMOS-AQ forecasts themselves at SCRIBE stations that are collocated with or near air quality stations. This is minimized by considering UMOS-AQ forecasts as perfect (standard deviation of error set to 0):

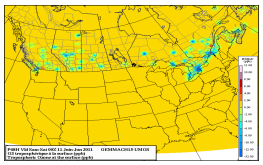


[O3] 20 June, 2011 @ 12Z

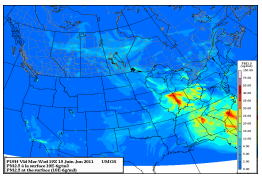
Example Forecasts and Increments

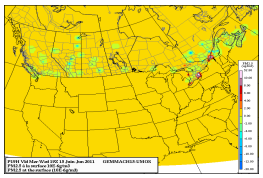
UMOS-AQ/MIST	GEMMACH15 – UMOS-AQ



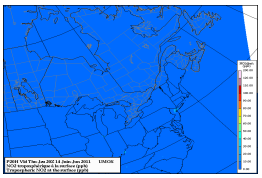


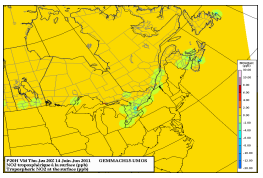
[O3], 48H Fcst Vld 11 June 2011 00Z, Dom: North America





[PM25], 19H Fcst Vld 15 June 2011 19Z, Dom: North America





[NO2], 20H Fcst. Vld 14 Juin 2011 20Z, Dom: East

Current Status / Future Work

- UMOS-AQ / MIST has been in operational status at the Canadian Meteorological Center (CMC) since July 2011.
- Future improvements should produce direct point forecasts in the SCRIBE stations along with the field forecasts in order to eliminate the second interpolation step.
- Expansion of the technique in order to include meteorological variables and simplify the addition of new stations in the SCRIBE dictionary.

REFERENCES / CONTACT

1) *The Canadian Updatable Model Output Statistics (UMOS) System: Design and Development Tests*, Laurence J. Wilson, Marcel Vallee, *Weather And Forecasting,Vol.17*

2) *An Updatable Model Output Statistics Scheme.* G.H. Ross, UK Met. Office

3) *A Canadian Precipitation Analysis (CaPA) Project: Description and Preliminary Results*, Mahfouf, J.-F., B. Brasnett, and S. Gagnon, *Atmos.–Ocean*, 45, 1–17

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